

Hand instrumentation in root canal preparation

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Root canal preparation using traditional stainless-steel ISO 0.01 tapered instruments by hand very often results in iatrogenic damage to curved root canals. A further disadvantage is their tendency to create narrow canal shapes which makes effective access for irrigants more difficult and apical extrusion of debris more likely. The major advantage of NiTi alloy is its ability to retain flexibility with increased taper. This has resulted in the development of two groups of NiTi hand instruments – The GT Instruments which have 2–6 times the taper of ISO 0.02 files and Hand ProTaper which have a variable taper. Both are used with a crown-down sequence. These NiTi Hand instrumentation methods leave good tactile feedback and the start-up costs are low. They are an excellent teaching tool and a useful introduction to NiTi Rotary Techniques. They can be used exclusively or in conjunction with or complementary to rotary techniques. Hand NiTi instruments can be selected in teeth with difficult canal anatomy, secure apical curvature or awkward access for a hand piece.

Traditionally, canal shaping has been achieved using ISO-normed 0.02 tapered stainless steel instruments manipulated by hand. The 16 mm bladed area of these instruments becomes wider by 0.02 mm every millimeter along their length and they have a tip that can be sharp or non-cutting. Although instruments are available as reamers or files, most reports recommend the use of the latter. K-type files and reamers are reasonably effective both in a linear filing motion as well as in a rotational motion, while the Hedström pattern of file should only be used in a filing motion.

The preparation sequence advocated originally for traditional hand instruments involved determining working length radiographically followed by preparation of the canal from the apical constriction to the orifice. The files were used with a filing action, the apical constriction being enlarged empirically and a step-back

sequence of instrumentation carried out to create a flared shape that acted as a reservoir for irrigants and a suitable form for obturation. Unfortunately, when carried out in curved canals such procedure, often results in iatrogenic damage to the natural shape of the canal, particularly in its apical third. This effect is caused by the inherent inability of all but the smallest stainless steel files to follow the curve of the canal. Stainless steel files in sizes above #15 or 20 become inflexible and have a tendency to straighten causing deviation from the original canal shape resulting in over-cutting on the outer wall in the apical region (zipping, ledging) and along the inner wall more coronally, particularly at the start of the curve (danger zone).

A further disadvantage of 0.02 taper hand instruments is their tendency to create narrow canal shapes minimizing access of irrigants and creating potential to

Table 1. The balanced force movement of files

A straight file is placed into the root canal until it binds against the wall

The file is then rotated clockwise through 60–90° so that it binds, threads within the dentine and advances apically

The file is moved anticlockwise through 120–180° with apical pressure, crushing and breaking off the dentine threads and enlarging the root canal

A final clockwise rotation without apical advancement allows flutes to be loaded with debris and removed from the canal

allow debris to be pushed apically. Attempts at overcoming the deficiencies of these instruments resulted in a number of preparation techniques that aimed to reduce iatrogenic defects and produce canals with a more flared shape. At the same time, the introduction of very flexible instruments made from nickel-titanium alloy have resulted in instruments that have the ability to pass around curves more readily. However, most cases still require the use of stainless steel instruments for checking canal patency bypassing ledges etc.

The crown down sequence of instrumentation has largely superseded the outdated stepback method. The potential advantages of root canal hand preparation from crown to apex with early coronal flaring include:

- less risk of inoculation of endodontic pathogens into the periradicular tissues
- enhanced penetration of irrigant into the root canal system

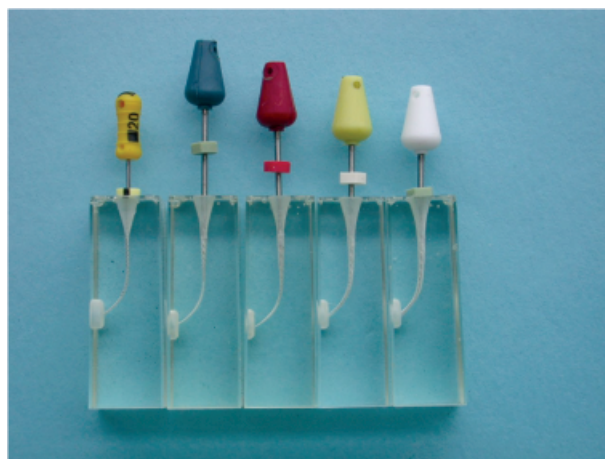


Fig. 1. GT hand files inserted into plastic blocks with curved simulated root canals to demonstrate crown down preparation. Note large color-coded handles compared with a conventional K-file #20 at the far left. Courtesy of Dr P. Carrotte.

Table 2. Instrumentation of curved canals using GT hand files

Having ensured straight line access and confirmed canal patency, the following sequence should be used:

3–4 mm of coronal flare with an engine-driven instrument such as a NiTi Orifice Shaper run at low speed

Dip each instrument in an EDTA paste before introduction into the root canal to facilitate both smear layer removal and lubrication

Thorough irrigation

With reverse balanced force (60° anticlockwise movement, followed by a 120° clockwise movement with apical pressure) use GT files largest (BLUE) to smallest (WHITE) in a crown down sequence progressively towards the apex

0.12 taper BLUE (6 times ISO)



0.10 taper RED (5 times ISO)



0.08 taper YELLOW (4 times ISO)



0.06 taper WHITE (3 times ISO)

Repeat more than once if required to achieve preparation to just short of the estimated working length

Working length confirmed radiographically and with electronic apex locator

Use 0.02 tapered ISO files, preferably made of NiTi, with conventional balanced force to enlarge the apical preparation if considered necessary

Complete preparation to the full working length using a GT hand file of appropriate taper for the canal size. This is a most important last stage in the preparation procedure as it ensures a smooth apical taper or 'deep shape' in order to facilitate irrigation and obturation

Table 3. Instrumentation of curved canals using ProTaper hand files

Having ensured straight line access and confirmed canal patency, the following sequence should be used:

3–4 mm of coronal flare with an engine-driven instrument such as a NiTi Orifice Shaper run at low speed

Dip each instrument in an EDTA paste before introduction into the root canal to facilitate both smear layer removal and lubrication

Thorough irrigation

With all clockwise rotation use ProTaper instruments in a crown down sequence progressively towards the apex

S1 to half or two-thirds of estimated canal length



SX to half or two-thirds of estimated canal length



S1 to canal length



S2 to canal length



F1 to canal length



F2 followed by F3 to length if required



Repeat more than once if required to achieve preparation to just short of the estimated working length

Working length confirmed radiographically and with electronic apex locator

Use 0.02 tapered ISO files, preferably made of NiTi, with conventional balanced force to enlarge the apical preparation if considered necessary

- less risk of extrusion of irrigant solution and debris
- less likelihood for a change in the working length measurement during preparation
- greater tactile awareness of the apical constriction
- more effective performance of electronic apex locators
- reduced coronal binding of instruments

A significant advance in root canal preparation with hand instruments was made with the introduction of the balanced force movement of files. This technique is essentially a reaming action using clockwise movement to insert the file and anticlockwise movement to remove dentine. The files must be straight, not pre-curved, preferably having a non-cutting tip and may be of stainless steel or nickel–titanium (Table 1).

Balanced force manipulation of hand instruments during root canal preparation procedures has been shown to be efficient and less prone to cause iatrogenic damage and maintains the instruments centrally within the root canal. Extrusion of debris apically is also reduced, resulting in less postoperative pain.

A major advantage of nickel–titanium alloy is its ability to retain flexibility with increased taper. This has resulted in the development of groups of instruments that have a two to six times greater taper than the ISO standardized 0.02 file and/or to have a variable taper. They are available as GT hand instruments (Dentsply Maillefer, Ballaigues, Switzerland) and ProTaper hand instruments (Dentsply Maillefer).

Both instruments appear to offer many advantages over traditional 0.02 taper hand instruments. Both

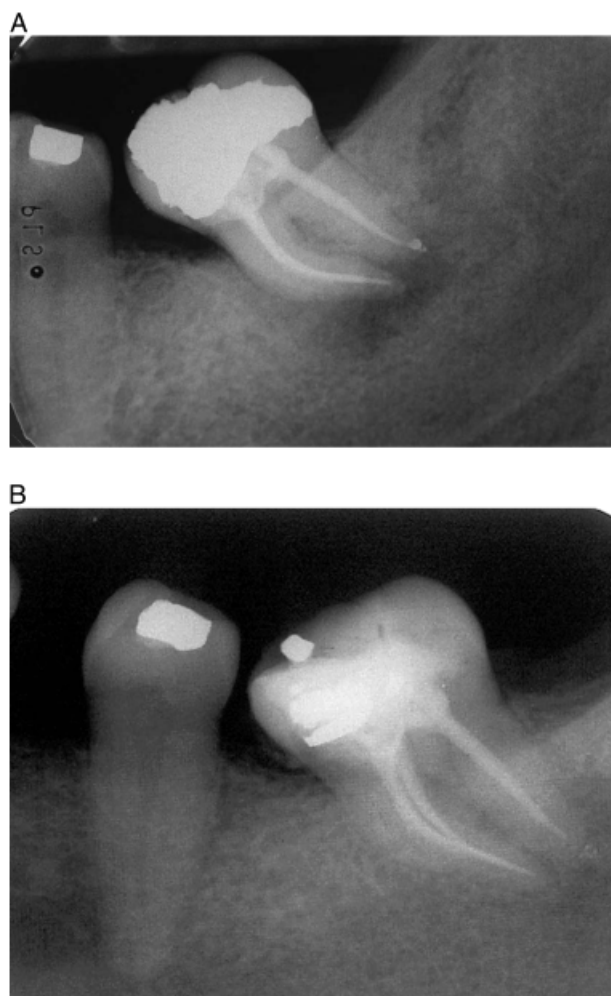


Fig. 2. Mandibular molar diagnosed with periradicular periodontitis treated using GT hand files. Note significant curvature of mesial root. (A) Postoperative radiograph. (B) follow-up radiograph.

instruments can and should be used in conjunction with or complementary to rotary techniques. It should not be a case of selecting either hand or rotary NiTi instrumentation exclusively. Both these NiTi hand instrumentation methods are also proving to be an excellent teaching tool for undergraduates as they give good tactile feedback and have lower start-up costs. They are also useful as an introduction for first time NiTi rotary users.

Hand NiTi instruments can also be selected instead of rotary instruments in teeth with difficult canal anatomy and/or problematic handpiece access. Hand instrumentation is particularly useful as an adjunct to rotary preparation where the canal system exhibits severe curvature in its apical third.

Instrumentation with GT hand files

GT Hand files (Fig. 1) have large plastic handles and are manufactured in four tapers (06 (white handle), 08 (yellow), 10 (red) and 12 (blue)), and in three lengths: 21, 25 and 30 mm. Presently all GT hand files have size #20 non-cutting tip but will be available in the near future in sizes #30 and #40 with tapers 0.04 to 0.10.

Flaring of the coronal 3–4 mm of the root canal may be achieved using a rotary Gates Glidden drill. However, this instrument cuts rather indiscriminately and also has a tendency to push dentine debris ahead of itself. By using a NiTi rotary Orifice Shaper (Dentsply Maillefer) of some description the desired flare is achieved immediately and more predictably.

A technique of 'reverse balanced force' has to be used with GT hand files as the flutes of these instruments are machined with an opposite thread to all other files. Table 2.

Instrumentation with ProTaper hand files

Plastic handles recently became available for ProTaper instruments enabling their use as hand instruments. Their design and sequence of use mirrors that used by the established rotary version (Table 3).

The amount of preparation carried out in the apical region of the canal is the subject of considerable controversy. Some believe that it is unnecessary to widen the apical preparation because pre-flaring and patency filing will allow the irrigant to reach and be agitated in the apical part of the canal to ensure cleaning will take place. Others consider it necessary to remove infected dentine in the apical few millimeters by shaping to at least a size 30 file. Certainly, widening of the apical part of the canal to a reasonable size after preparation of the coronal and middle sections allows more effective obturation if cold lateral compaction is the root filling technique selected.

Conclusion

Current NiTi hand preparation procedures that use files with a greater or variable taper are a substantial improvement over instrumentation with 0.02 tapered stainless steel files particularly when used in curved root canals (Fig. 2). These newer instruments should produce canals with a better shape, using fewer instruments and

in a shorter time. Such instruments are also a most useful adjunct to rotary canal preparation.

Further reading

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4. Stabholz A, Rotstein I, Torabinejad M. Effect of preflaring on detection of apical constriction. *J Endod* 1995; **21**: 92–96.

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